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Research Article

Xantolis weimingii (Sapotaceae), a new species from the Yuanjiang River basin, Yunnan, southwest China

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Abstract

Xantolis weimingii **sp. nov.** (Sapotaceae) is described and illustrated from Yunnan, southwest China. The new species is morphologically most similar to *X. tomentosa* (Roxb.) Raf., but differs from the latter in the ovate or obovate leaves, entirely glabrous corollas, lanceolate, ca. 5 mm long staminodes, fringed at the base. We provided a distribution map and a preliminary conservation assessment for the new species. Additionally, an updated dichotomous key to all known species of *Xantolis* is presented.

Key words: Central Yunnan, critically endangered, dry-hot valley, endemism, staminode

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Introduction

Xantolis Raf. (Sapotaceae, Chrysophylloideae) is a small genus of trees and shrubs that comprises approximately 14 species (van Royen 1957; Swenson and Anderberg 2005). Its distribution ranges from the eastern Himalayas to the Philippines in tropical Asia (van Royen 1957; Li 1987; Li and Pennington 1996). This genus is morphologically characterized by having obvious spines, acute anther appendages, lanceolate lobes of calyx and corolla, and aristate staminodes (Swenson and Anderberg 2005). Some members of the genus are of significant economic importance due to their edible fruits and high-quality timber (Li 1987).

The systematic position of *Xantolis* has been controversial. Pennington (1991) classified it as a member of the large tribe Chrysophylleae. Recent studies based on molecular data have demonstrated that *Xantolis* is recovered as a sister to the rest of the subfamily Chrysophylloideae, being a very isolated and poorly understood genus (Anderberg and Swenson 2003; Bartish et al. 2005, 2011; Swenson and Anderberg 2005). Therefore, further extensive sampling is still required to test the monophyly and synapomorphic characters, generic status, and phylogenetic position of *Xantolis* (Triono et al. 2007; Stride et al. 2014; Swenson et al. 2023).

* These authors contributed equally to this work.

The Yuanjiang River is the mainstream of the upper reaches of the Hong (Red) River, while the Luzhijiang River, situated in central Yunnan in southwest China, is an upper tributary of the Hong River. The rain shadow effect created by the Ailao-Wuliang Mountains and the Yunnan-Guizhou Plateau results in a distinctive hot and dry climate in these valleys, in contrast to most of the surrounding regions (Jin and Ou 2000; Li et al. 2016). The climate in this region is characterized by a dry season (which can be further divided into a cool dry season from November to February and a hot dry season from March to April), with an annual average temperature of 24 °C and a mean annual evaporation capacity of 2700–3800 mm, which is three to six times higher than the mean annual precipitation (600–800 mm). There is also a wet season from May to October, during which 80–90% of the precipitation is concentrated (Jin 2002; Shen et al. 2010; Zhou et al. 2017). The relatively closed environment of the area has led to the formation and retention of a large number of rare and endangered plants and endemic species (Li et al. 2008; Ma 2016). Knowledge of biodiversity in the region seems far from complete, with many new species being described in recent years in different lineages of organisms (Bai et al. 2015; Zhou et al. 2017; Qiao et al. 2018; Yang et al. 2019; Ding et al. 2020; Liu et al. 2022; Ma et al. 2022; Wang et al. 2022; Yang et al. 2022a, 2022b, 2022c; Ma et al. 2023).

The new species of *Xantolis* described here, *X. weimingii* Huan C. Wang & Feng Yang, was first collected in the Luzhijiang Valley in August 2015. During our subsequent fieldwork, we encountered this species several times. However, only sterile or fruiting specimens were collected. In April 2022, the specimen with flowers was finally gathered in Wadie, Yuanjiang County. After a detailed comparison with morphologically similar species, we confirmed its novelty to science and describe it here as *Xantolis weimingii* Huan C. Wang & Feng Yang.

Materials and methods

Based on the morphological species concept defined by Cronquist (1978), the morphological studies of the new species were conducted on living plants and specimens coming from the four localities corresponding to the holotype and paratypes. The digital specimen images of similar species available at JSTOR Global Plants (https://plants.jstor.org/), the Smithsonian National Museum of Natural History (https://collections.nmnh.si.edu/search/botany/), and the Global Biodiversity Information Facility (https://www.gbif.org/) were extensively reviewed. Pertinent taxonomic literature (e.g. Clarke 1882; van Royen 1957; Aubréville 1963; Luo 1974; Wu 1977; Li 1987; Luo 1991; Li and Pennington 1996; Pham 1999; Santisuk et al. 2014; Sankara et al. 2019; Turner 2021) were extensively consulted. Measurements were taken using a ruler and a metric vernier caliper under a stereomicroscope (Olympus SZX2, Tokyo, Japan). The dot-distribution map was compiled from all specimens studied and generated with ArcGIS version 10.4 (ESRI, Inc., Redlands, USA). The conservation status was assessed using GeoCAT (online tool available at https://geocat.iucnredlist.org/) (Bachman et al. 2011) to estimate the extent of occurrence (EOO) and the area of occupancy (AOO) of the species, followed by applying the IUCN Red List Categories and Criteria (IUCN 2022) for conservation status assessment. The characters used in the identification key for the congeners mainly followed those of Van Royen (1957) and Li and Pennington (1996).

Taxonomy

***Xantolis weimingii* Huan C. Wang & Feng Yang, sp. nov.**
urn:lsid:ipni.org:names:77348184-1
Figs 1–4

Type. China • Yunnan Province: Yuanjiang County, Wadie village, Luozhi village, near the junction of the Yuanjiang River and Hedihe River, 23°25'51.9"N, 102°18'42.4"E, alt. 1100 m, 14 April 2022, *C. Chen & Z. X. Li YJ19450* (holotype: YUKU 02074716!; isotypes: YUKU!).

Diagnosis. *Xantolis weimingii* is most similar to *X. tomentosa* (Roxb.) Raf., but can be easily distinguished by its ovate or obovate (vs. elliptic or elliptic-oblong in *X. tomentosa*) leaves, base broadly cuneate or nearly round (vs. cuneate), apex acute or acuminate (vs. obtuse, short obtusely or acutely acuminate), corollas entirely glabrous (vs. densely hairy at throat), 7.7–9.7 (vs. 4–8) mm long, lanceolate staminodes, ca. 5 (vs. 3–3.5) mm long, apex acuminate into an awn, fringed at the base (vs. broad base, not fringed), glabrous (vs. hairy).

Description. Shrubs or small trees, 2–4 m tall, evergreen, acanthaceous, laticiferous. Bark pale gray, cracked, shallowly and vertically fissured. Branches terete, gray to grayish black; branchlets densely ferruginous arachnoid-lanate, more or less glabrescent when old. Acantha usually axillary, straight, cuspidate, ca. 7 mm long. Petioles 4–8 mm long, with a slight furrow on the adaxial side, densely ferruginous arachnoid-lanate when young, gradually shedding, sparse or glabrescent when old. Leaves ovate to obovate, alternate, leathery, 2.0–8.5 cm long, 1.5–5.0 cm wide, base broadly cuneate or nearly round, apex acute to acuminate, slightly revolute, margin entire, adaxially dark-green, shiny, densely ferruginous arachnoid-lanate when young, glabrescent, abaxially densely ferruginous arachnoid-lanate when young, gradually faded to gray-green sericeous, or to glabrescent when old; midrib flat, obvious adaxially, prominent abaxially, lateral veins 6–9 pairs, arcuate, rising at an angle of 35°–50°, apex bifurcation near the margin, irregularly connected, tertiary and reticulate veins convex abaxially. Flowers in 1–5-flowered clusters in leaf axils or along old branches, pendant. Pedicels stout, terete, 3–4 mm long, densely ferruginous arachnoid-lanate. Calyx cup-shaped, 5-lobed, rarely 4-lobed; sepals imbricate, ovate to triangular, 6–7 mm long, 3.5–4.5 mm wide, apex acute, inside white pubescent on the upper part, outside densely ferruginous arachnoid-lanate. Corolla sympetalous, 5-merous, glabrous, slightly fleshy, tube ca. 4 mm long, lobes lanceolate, 3.7–5.7 mm long, apex acuminate, margin slightly involute, dentate at the base. Stamens 5, adnate to corolla tube at the base, opposite to lobes, filaments white, linear, 2.8–3.5 mm long; anthers sagittate, yellow, ca. 3 mm long, dorsifixed, longitudinal, apex acuminate, base cordate. Staminodes 5, glabrous adnate to corolla tube at the base, alternate to lobes, white, lanceolate, ca. 5 mm long, 1–2 mm wide at the base, apex acuminate into an awn, fringed at the base, glabrous. Ovary ovoid, densely brown pilose; style terete, yellow-green, ca. 8 mm long. Fruits ovoid, oblong or elliptic, with ferruginous arachnoid-lanate hairs, 2.2–4.5 cm long, 1.2–1.5 cm in diam., with persistent calyx, apex sometimes beaked, with persistent style, 1-seeded. Seeds oblong to ellipsoid, slightly compressed, 2–2.5 cm long, ca. 8 mm in diam., both ends truncate, pericarp woody, shiny yellowish brown, scar elliptic, 1.5–2 cm long, ca. 3 mm wide, whitish.

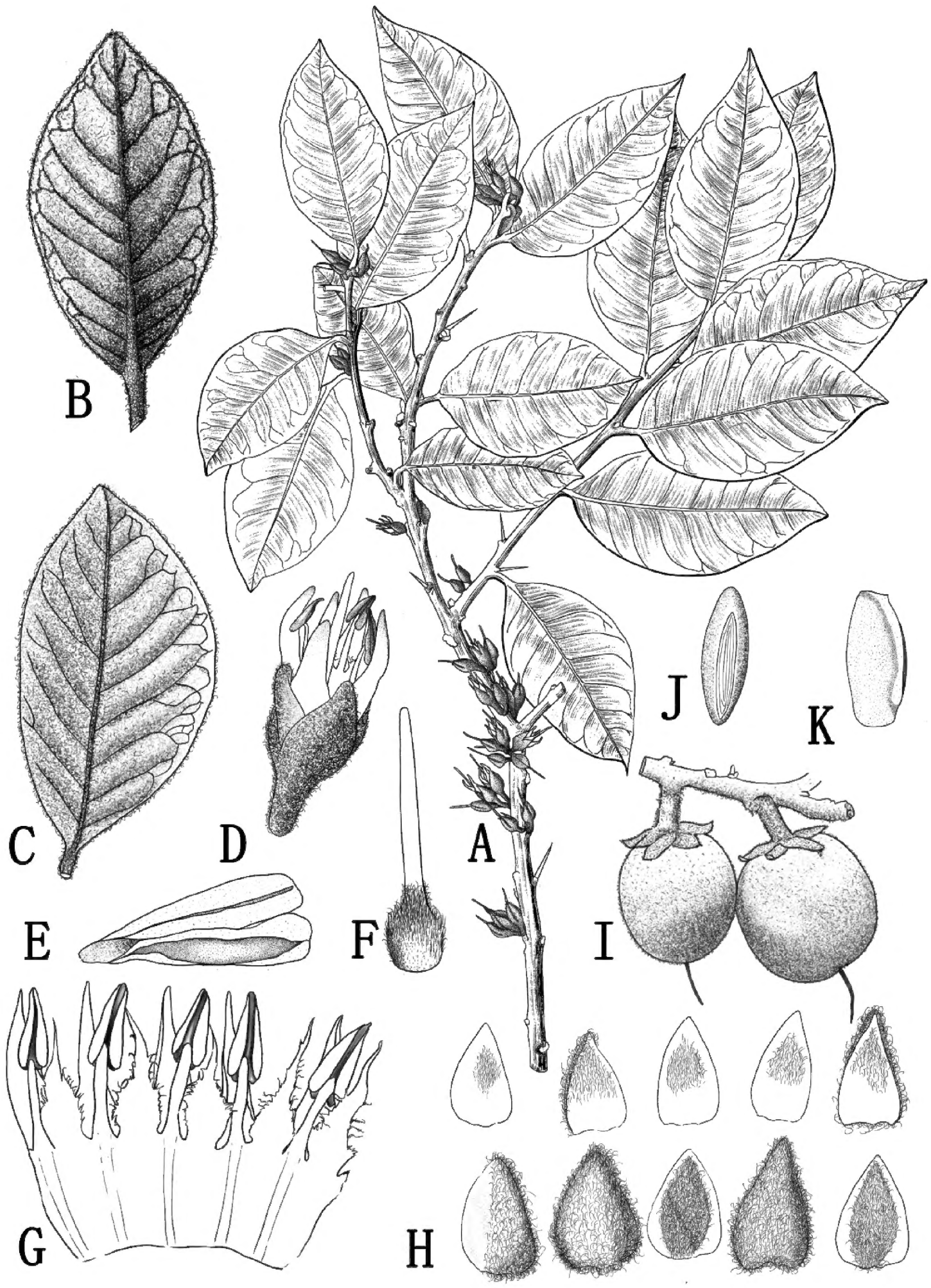

Figure 1. *Xantolis weimingii* sp. nov. (drawn by Qiu-Ping Wang) **A** habit **B** abaxial surface of leaf **C** adaxial surface of leaf **D** flower in blooming **E** anthers **F** pistil **G** corolla dissected to show stamens and staminodes **H** calyx lobes (the upper line is the inner view, the lower line is the outer view) **I** fruits **J** side view of seed to show scar **K** front view of seed.

Phenology. Flowering from April to May, and fruiting from May to October.

Etymology. The new species is named after Professor Weiming Zhu (朱维明-Wei Ming Chu, 1930–2023), a renowned botanist from Yunnan University, in recognition of his outstanding contributions to the study of China's flora of Lycophytes and Ferns and to the Herbarium of Yunnan University (Kunming, China).

Distribution and habitat. *Xantolis weimingii* is a rarely and poorly collected species endemic to the central Yunnan province in southwest China. As of now, it has been discovered in four different sites, all situated in the dry and hot valleys of both the Yuanjiang River and its primary tributary, the Luzhijiang River

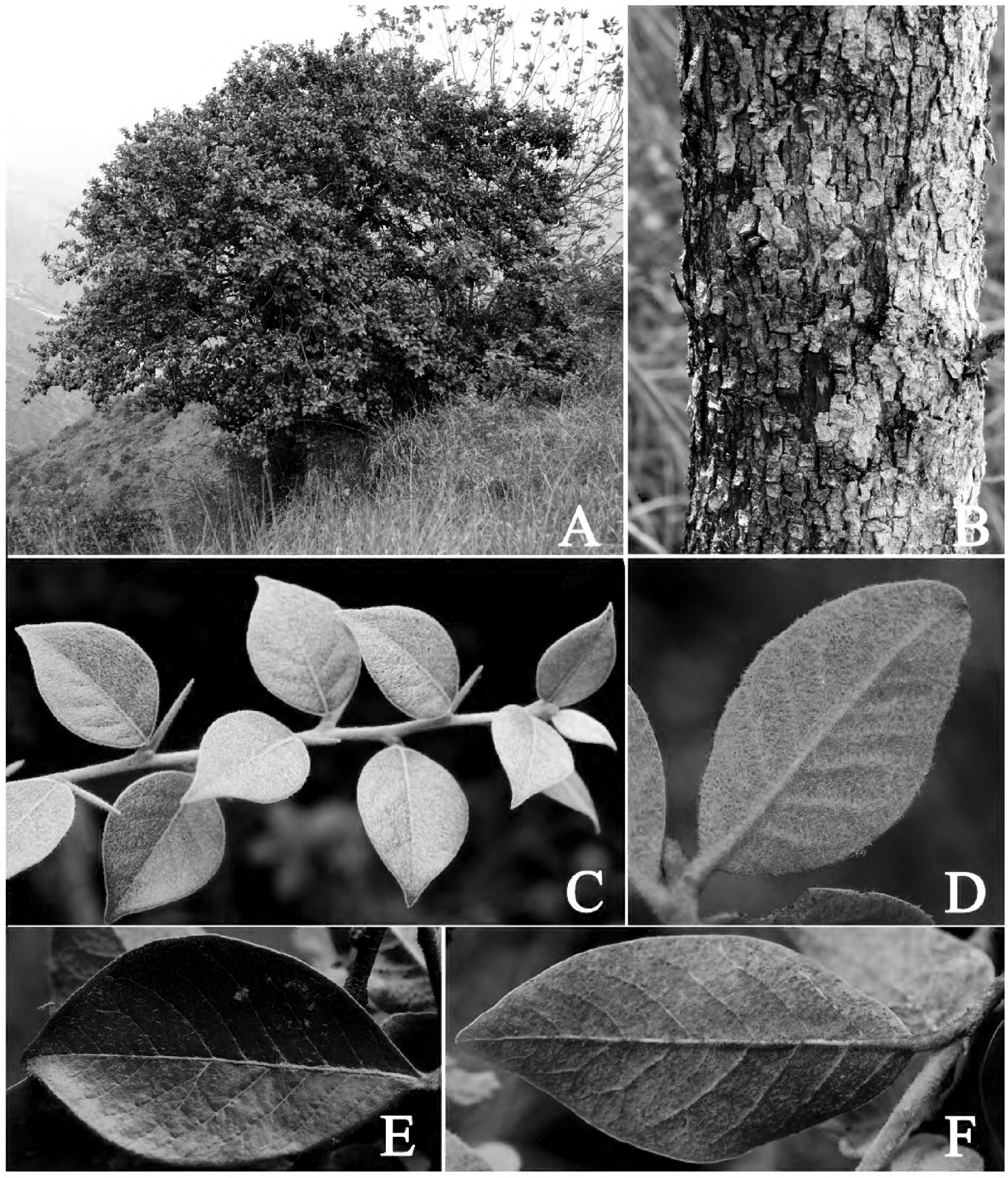

Figure 2. *Xantolis weimingii* sp. nov. **A** habit **B** trunk showing bark texture **C** branchlet **D** abaxial surface of tender leaf **E** adaxial surface of leaf **F** abaxial surface of leaf.

(Fig. 5). This new species grows in savanna habitats on the mountain slopes at elevations ranging from 1100 to 1400 m (Fig. 6).

Preliminary conservation assessment. *Xantolis weimingii* is at a restricted geographic range, with an estimated extent of occurrence (EOO) of 139.594 km^2 and an area of occupancy (AOO) of 12 km^2. Four populations of the new species have been discovered: two of them from the same locality (Yimen County), and one in the Yuanjiang National Nature Reserve. Unfortunately, these populations are typically small, ranging from three to a maximum of eight plants. So far, we have not found any saplings or seedlings in the Yuanjiang and Fawu populations, and we judged that the self-renewal capacity of the wild population of this species is low. The other populations in the Luzhijiang River valley at Yimen County are most threatened. The hillside land here is highly degraded and soil erosion is serious due to mining operations. Furthermore, residents had been harvesting the plant for firewood, resulting in the plant becoming a shrub-like appearance. Therefore, *Xantolis weimingii* is at a high risk of extinction due to

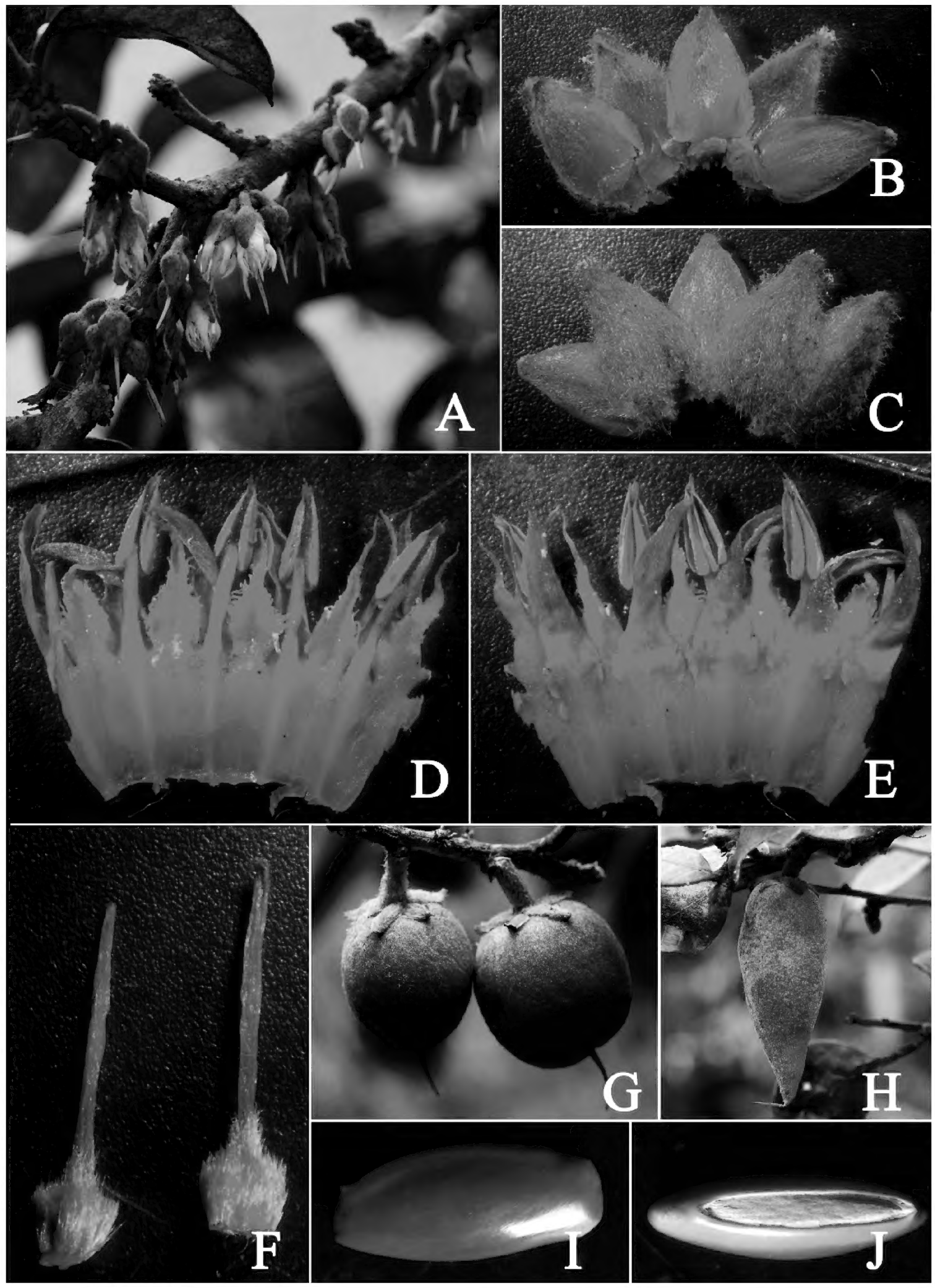

Figure 3. *Xantolis weimingii* sp. nov. **A** flowering branch **B** adaxial view of sepals **C** abaxial view of sepals **D** corolla dissected to show five stamens and five staminodes **E** corolla dissected to show five lobes **F** pistils **G–H** fruits **I** front view of seed **J** side view of seed to show scar.

a restricted geographic range, fragmented distribution, small population sizes, and fragile living environment. Based on IUCN Red List Categories and Criteria (IUCN 2022), we suggest a Critically Endangered (CR) category for the species.

Discussion. *Xantolis weimingii* can be easily distinguished from its congeners by the following combination of characters: plants densely covered with ferruginous arachnoid-lanate, leaves ovate or obovate, and staminodes fringed at the base. It is most similar to *X. tomentosa* (excluding the synonym *Planchonella dongnaiensis* Pierre ex Dubard), which is widely distributed in Sri

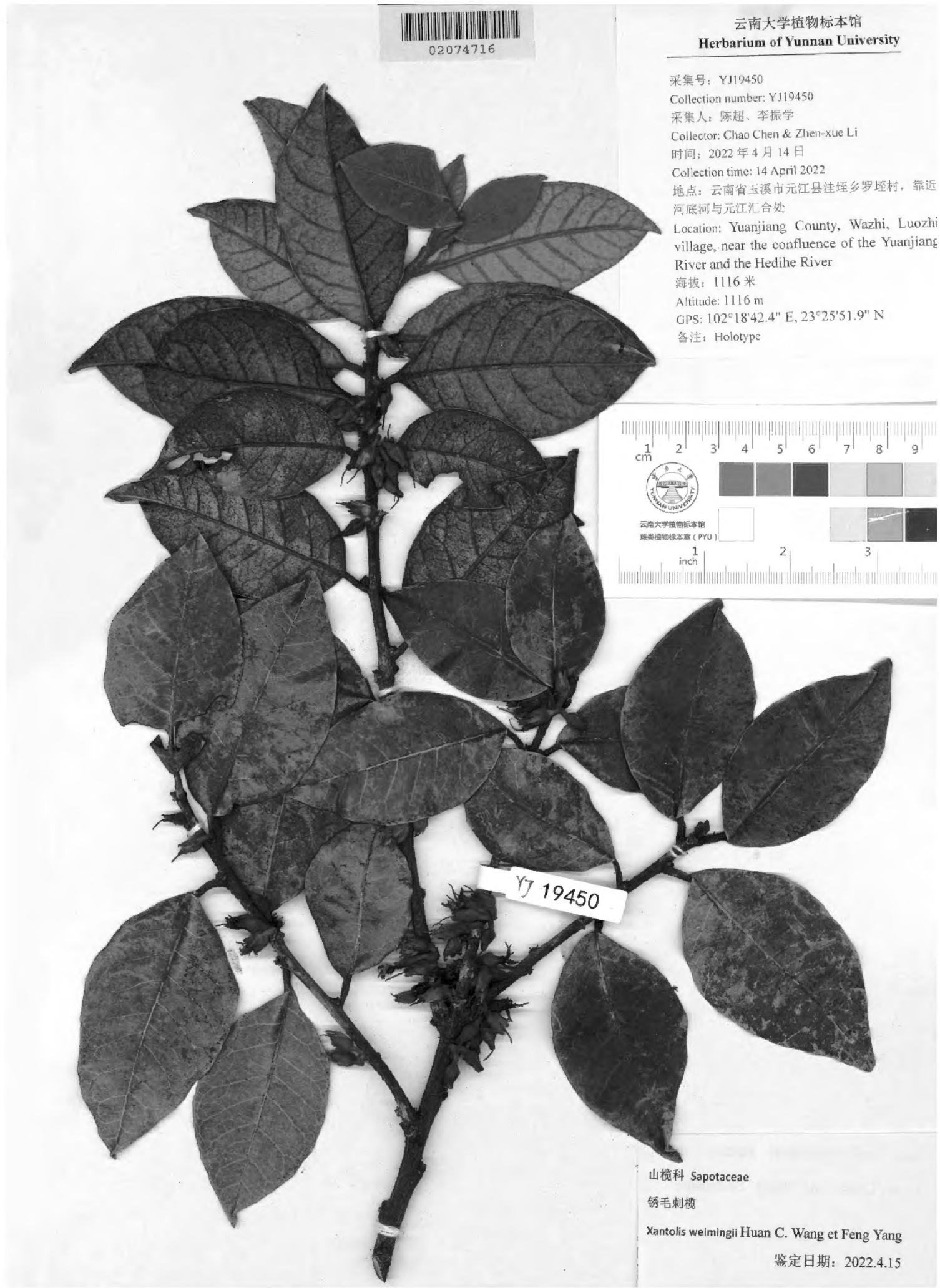

Figure 4. Holotype of *Xantolis weimingii* sp. nov. (YUKU-02074716).

Lanka, India, and Myanmar. However, it differs clearly from the latter by having pale gray (vs. light reddish brown in *X. tomentosa*) barks, ovate or obovate (vs. elliptic, elliptic-oblong) leaves, 2–8 (vs. 4–14) cm long, 1.5–5.0 (vs. 2–6) cm wide, base broadly cuneate or nearly round (vs. cuneate), apex acute or acuminate (vs. obtuse or short obtusely or acutely acuminate), 6–9 (vs. 8–l6) pairs lateral veins, 4–8 (vs. 3–20) mm long petioles, 3–4 (vs. 4–7) mm long pedicels, entirely glabrous (vs. throat densely hairy) corollas, 7.7–9.7 (vs. 4–8) mm long, lanceolate (vs. lanceolate-oblong or ovate) lobes, staminodes ca. 5 (vs. 3–3.5) mm long, 1–2 mm wide at the base, apex acuminate into an awn, fringed at the base (vs. broad base, not fringed), glabrous (vs. hairy).

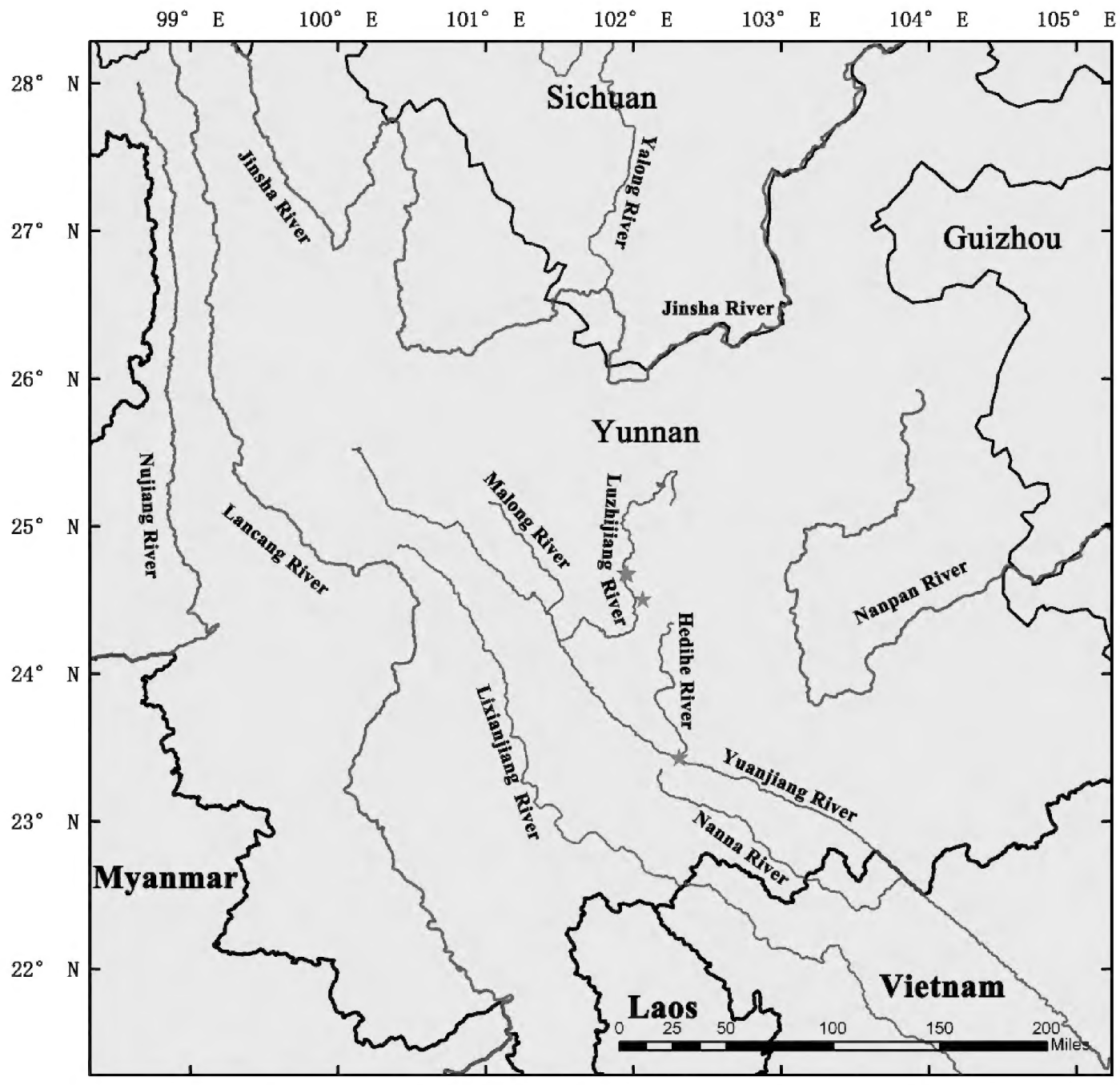

Figure 5. Known geographical distribution of *Xantolis weimingii* (red stars). Based on all known collections.

Xantolis weimingii is also morphologically similar to *X. cambodiana* (Pierre ex Dubard) P. Royen from Indo-China. Nevertheless, *X. weimingii* differs from *X. cambodiana* in having ovate to obovate (vs. rhomboid-obovate or elliptic, sometimes lanceolate in *X. cambodiana*) leaves, base broadly cuneate or nearly round (vs. tapering towards the base), apex acute to acuminate (vs. obtuse, entire or retuse, sometimes short obtusely acuminate), ovate to triangular (vs. ovate or oblong) sepals, 6–7 (vs. 2.5–4) mm long, 3.5–4.5 (vs. 1–2) mm wide, lanceolate (vs. lanceolate or linear) staminodes, ca. 5 (vs. 2–3) mm long, 1–2 (vs. ca.0.5) mm wide at the base. *Xantolis weimingii* shares similar fruits with *X. assamica* (C.B. Clarke) P. Royen, a species occurring in Assam to Bangladesh, but differs from the latter in its 4–8 (vs. 5–15) mm long petioles, ovate to obovate (vs. ovate, elliptic or broadly lanceolate) leaves, 2.0–8.5 (vs. 6–16.5) cm long, 1.5–5.0 (vs. 2–7) cm wide.

Additional specimens examined. China • Yunnan: Yimen County, near Xiaoluzhi village, the west side of Luzhijiang valley, 24°40'46.21"N, 101°56'49"E, 25 September 2015, *H. C. Wang et al. YM241* (YUKU, plant in vegetative period); same location, 27 April 2016, *H. C. Wang et al. YM863* (YUKU, plant in vegetative period); Luzhijiang valley, near Luzhi town, 12 November 2019, *H. C. Wang et al. YM8317* (YUKU, plant in vegetative period); • Luzhijiang valley, near Xiaoluzhi village, Maomao mountain, on the limestone of the dry-hot valley, 24°40'30.9"N, 101°57'37.21"E, elev. 1392.46 m, 25 December 2021, *H. C. Wang et al. YM14630* (YUKU, plant in vegetative period); • Eshan County, Dalongtan, the mountain

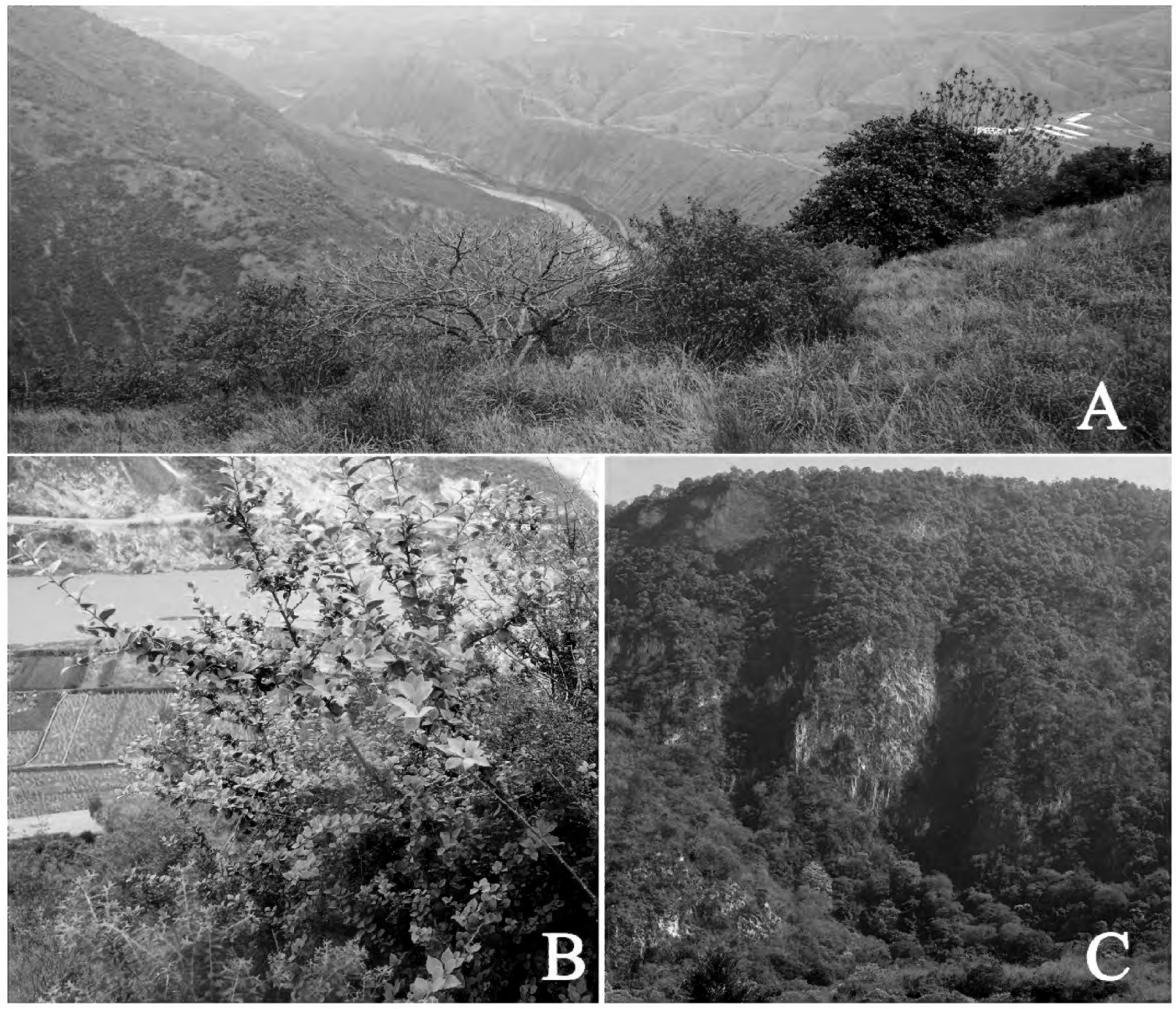

Figure 6. Habitat of *Xantolis weimingii* **A** habitat of the Yuanjiang population **B** habitat of the Yimen population **C** habitat of the Eshan population.

behind the Fawu village, 24°30'14.17"N, 102°03'46.60"E, alt. 1400 m, 20 August 2015, *H. C. Wang et al. ES173* (YUKU, plant during grain-filling period); • same location, 9 June 2016, *H. C. Wang et al. ES866* (YUKU, plant in late flowering and fruiting period); • same location, 17 September 2017, *H. C. Wang et al. ES2450* (YUKU, plant during grain-filling period); • same location, 27 April 2022, *H. C. Wang et al. YM16402* (YUKU, plant in vegetative period).

Identification key to the species of *Xantolis*

1 Lateral veins numerous, not convex abaxially **2**
– Lateral veins few, conspicuously elevated abaxially **5**
2 Sepals glabrous adaxial, staminodes pubescent adaxial ..... ***X. baranensis***
– Sepals pubescent adaxial, staminodes glabrous adaxial **3**
3 Stems sometimes creeping, with numerous spines; leaves suborbicular .. .. ***X. maritima***
– Stems not creeping, sometimes with occasional spines; leaves spatulate, obovate-oblong, obovate or elliptic **4**
4 Flowers small, corolla 6–9 mm long, lobes lanceolate, 5–6 mm long, ca. 1.5 mm wide, stamens 4–5 mm long, staminodes lanceolate, ca. 3 mm long ..... ***X. parvifolia***
– Flowers slightly larger, corolla 10–14 mm long, lobes linear, 7–10.5 mm long, 2–3 mm wide, stamens 6–8.5 mm long, staminodes ovate, 4–7.5 mm long ..... ***X. longispinosa***

5 Aspect ratio of mature leaves 1.3–2.5 ..... **6**
– Aspect ratio of mature leaves 2–4 ..... **11**
6 Pedicels 7–11 mm long ..... ***X. burmanica***
– Pedicels 3–7 mm long **7**
7 Staminodes fringed at the base **8**
– Staminodes not fringed at the base **10**
8 Flowers in clusters along 0.7–3 cm long axillary shoots ..... ***X. racemosa***
– Flowers solitary or in clusters along branchlets **9**
9 Leaf blades ovate or obovate, apex acute to acuminate; staminodes longer than or equal to stamens ..... ***X. weimingii***
– Leaf blades rhomboid-obovate or elliptic, apex obtuse, entire or retuse; staminodes shorter than stamens ..... ***X. cambodiana***
10 Leaves spatulate or elliptic, sometimes rhomboid-oblong, 2–3.5 cm long, (0.6–) 1–2 cm wide, base tapering into petioles; secondary nerves 5–10, ascending at an angle of 40°–45° ..... ***X. siamensis***
– Leaves elliptic-oblong, ovate or obovate, 4–14 cm long, 2–6 cm wide, cuneate at the base, decurrent; secondary nerves 8–16, ascending at an angle of 50°–80° ..... ***X. tomentosa***
11 Leaves 12–22 cm long, 2–7 cm wide, secondary nerves 10–17; pedicels pubescent **12**
– Leaves 6–12 cm long, 2.8–5.5 cm wide, secondary nerves 5–13; pedicels glabrous **15**
12 Sepals ovate, apex subobtuse; corolla lobes 7–9 mm long, 2.5–3.5 mm wide; staminodes 6–7 mm long ..... ***X. hookeri***
– Sepals lanceolate, apex acute; corolla lobes 3–6 mm long, 1.5–2 mm wide; staminodes 2.5–4 mm long **13**
13 Leaves ovate, elliptic or broadly lanceolate, 6–16.5 cm long, 2–7 cm wide; secondary veins of leaf 9–15, ascending at an angle of 60°–85° ..... ***X. assamica***
– Leaves lanceolate, oblanceolate or oblong-lanceolate, 5–18 cm long, 2–5 cm wide; secondary veins of leaf 15–17, ascending at an angle of 40°–55° **14**
14 Sepals lanceolate to ovate-lanceolate, 4–6 mm long, 1.5–3 mm wide; fruit ferruginous, sericeous to pubescent ..... ***X. stenosepala***
– Sepals ovate, 3–4 mm long, 2–3 mm wide; fruit subglabrous ..... ***X. stenosepala* var. *brevistylis***
15 Corolla lobes fimbriate at the base ..... ***X. shweliensis***
– Corolla lobes entire **15**
16 Fruits glabrous; secondary veins of leaf 5–8, ascending at an angle of 35°–55° ..... ***X. boniana***
– Fruits pubescent; secondary veins of leaf 9–13, ascending at an angle of 50°–65° **17**
17 Scar of seed as long as the seed, seeds 2–3 cm long ..... ***X. boniana* var. *rostrata***
– Scar of seed 2/3 the length of the seed, seeds up to 2 cm long ..... ***X. boniana* var. *pavieana***

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Data availability

All of the data that support the findings of this study are available in the main text.

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